DENTAL IMPLANTS AND METHODS FOR THEIR FABRICATION AND USE

FIELD OF THE INVENTION

[0001] The present invention relates to restorative dentistry and other medical procedures and to implants and prostheses associated with such procedures. More particularly, the devices and methodology of the invention enables a replica of a nonfunctional tooth or other anatomical part to be fabricated, which replica decreases trauma associated with the utilization of commercial stock prosthesis systems.

BACKGROUND OF THE INVENTION

[0002] Dental implants are utilized in replacing nonfunctioning teeth. One example of a conventional implant is disclosed in U.S. Patent No. 6,290,500, the entire disclosure of which is incorporated herein by references.

[0003] Conventional implants include a base that is screwed or placed into a custom bored hole in the jaw of a patient. During bone healing, the implant is embedded in the bone, with the gum tissue growing over the implant. In the case of immediate implant placement where an implant is placed at the time a nonfunctional tooth is removed, care needs to be taken to ensure that no force is applied to the implant during healing. Such force will decrease the bone's ability to heal and integrate with the implant; accordingly, stabilization during this healing period is crucial. After several months for bone integration, a second surgery is performed in which the implant receives a healing abutment for forming gum contours around the implant. An abutment with a post is then mounted onto the base by way of a screw. A prosthetic tooth or crown is then fabricated and mounted on the abutment similar to that of conventional dental crown and bridge.

[0004] Conventional implants have several morbidities associated with it. The installation of the base into the bone of the jaw is traumatic. Bone drills are used to prepare the site where the nonfunctional tooth was extracted. These bone drills and corresponding implants are inherently elongated. By drilling, there is a risk of nerve damage and sinus perforation. Further, any misplacement in the bone makes the implant difficult to restore in the proper anatomic location.

In addition, fatigue in the two-part structure of the base and the abutment may lead to implant failure and breakage.

BRIEF SUMMARY OF THE INVENTION

[0005] According to one aspect of the invention, an implant for use in replacing a nonfunctional tooth includes an abutment and a base. The base of the implant has a topography this is substantially identical to the topography or superficial morphology of the root of the nonfunctional tooth. The implant may be fabricated from a single piece of material so that the abutment and the base are unitary. In addition, the surface of the base may be treated to enhance post-implant bone or ligament growth to the base.

[0006] In contrast to conventional devices, the implants of the invention eliminate the need for conventionally used bone drills and other traumatic site-preparation procedures. Other advantages include ease of use and minimal necessary parts and components. Further, in embodiments where the implant is unitary, there is no screw between the abutment and the base to loosen or break. In addition, the implants and methodology of the invention minimize or eliminate the need for bone grafting surgeries such as sinus lift procedures.

[0007] Still other advantages include the ability to shape or prepare the abutment similar to conventional crown and bridge preparations and the ability to custom make a replicate implant for each patient to ensure fit, adaptation, and patient acceptance. Further, the dental papilla is preserved which is necessary for esthetics of anterior restorations. The methodology ensures that the implant placed in a proper position, thereby minimizing guessing or necessary use of surgical guides or stents. Trauma is further mitigated in that the extraction and implantation may be done during a single-stage surgery.

[0008] The principles of the invention are not limited to uses in tooth replacement procedures but are applicable to any medical procedure in which it is advantageous to utilize a custom-made prosthesis that resembles or essentially replicates a nonfunctional anatomical part.

[0009] Other features and advantages of the present invention will become apparent to those skilled in the art from a consideration of the following detailed description taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION FO THE SEVERAL VIEWS OF THE DRAWINGS

[0010] FIG. **1** illustrates an implant according to a number of embodiments of the invention;

[0011] FIG. **2** illustrates a nonfunctional tooth;

[0012] FIG. **3** illustrates anatomical features of a tooth;

[0013] FIG. **4** illustrates an implant with a crown;

[0014] FIG. **5** illustrates methodology in fabricating an implant of the invention;

[0015] FIG. **6** illustrates methodology in fabricating and implanting an implant of the invention;

[0016] FIG. **6A** illustrates a digital-imaging process of a mouth of a patient;

[0017] FIG. **6B** illustrated a three-dimensional image of a jaw;

[0018] FIG. **7** illustrates an implant with a base having a treated surface;

[0019] FIG. **8** illustrates an implant with a base having holes bored therethrough;

[0020] FIG. **9** is a cross-sectional view of a nonfunctional tooth being removed;

[0021] FIG. **10** is a cross-sectional view of an implant being implanted;

[0022] FIG. **11** schematically illustrates plural stabilization devices;

[0023] FIG. **12** is a cross-sectional view illustrating discontinuities in a surface of an implant;

[0024] FIG. **13** illustrates an implant of the invention for use with a removable prosthesis according to a number of embodiments; and

[0025] FIG. **14** illustrates a non-unitary implant according to still other embodiments of the invention.

DETAILED DESCRIPTION OF THE INVENTION

[0026] Referring more particularly to the drawings, an implant **100** for use in replacing a nonfunctional tooth is illustrated in FIG. **1**. A nonfunctional tooth T is illustrated in FIG. **2** and has a root R with an anatomical topography. With additional reference to FIG. **3**, a tooth T also

has a neck N, and a crown C. For the purposes of this description, a subgingival portion S of a tooth T is defined as the portion of the tooth that extends below a surface of the gums, or gingival G. The subgingival portion S includes the root R and generally includes at least a portion of the neck N. The term "topography" is defined herein as a description of the surface morphology of an anatomical part, such as the root R, the neck N, and the subgingival portion S of a tooth T.

[0027] According to the invention, the implant **100** includes an abutment **102** and a base **104**. As know in the art, the abutment **102** of an implant is designed to receive an artificial crown **106**, as shown in FIG. **4**. As shown in FIGS. **1** and **2** and in contrast to conventional implants, the base **104** of the implant **100** has a topography this is substantially identical to that of the root R of the nonfunctional tooth T. In a number of embodiments, the implant **100** is fabricated from a single piece of biocompatible material, for example, titanium, so that the abutment **102** and the base **104** are unitary.

[0028] With additional reference to FIGS. **5** and **6**, when a dentist diagnoses a patient with a nonfunctional tooth (step **108**) and determines that the nonfunctional tooth needs to be replaced, the patient is sent to a medical lab where the mouth of the patient is scanned (step **110**), which is illustrated in FIG. **6A**. The scanning process may be any three-dimensional imaging process known in the art that is able to produce a digitized image of the topography of the nonfunctional tooth, such as computer-aided tomography (which is shown in FIG. **6A**), magnetic resonance imaging (MRI), and so on. Upon scanning, a digitized file of the mouth or jaw is created (step **112**), a three-dimensional representation of which is shown in FIG. **6B**.

[0029] According to some of the embodiments, the portion of the digitized file of the mouth relating to the nonfunctional tooth may then be extrapolated by computer software, thereby yielding a digitized file containing data essentially of the nonfunctional tooth (step **114**).

[0030] This digital file containing data relating to the implant further constructs the abutment 102 portion of the implant via software in the same way a dentist would prepare the tooth in the patient's mouth to receive a crown.

[0031] The digital file containing data relating to the anatomical topography of the nonfunctional tooth may then be sent to a fabricator (step **116**). The data from the digital file may then be utilized by an appropriate machine, such as a computer-aided manufacturing (CAM)

lathe, to mill an implant with a base that has substantially identical topography as that of the nonfunctional tooth (step **118**).

[0032] In additional to substantially identical topographies between the root R and the base **104**, in a number of embodiments, the milled implant **100** may also include substantially identical topographies between the neck N and an upper portion **120** of the base **102** (see FIG. **1**). In other embodiments, the base **104** of the implant **100** has a substantially identical topography as that of the subgingival portion S of the nonfunctional tooth T.

[0033] As mentioned above, in some of the embodiments, the implant **100** may be fabricated such that the abutment **102** and the base **104** are unitary. This may be accomplished by milling the implant **100** from a single piece of material.

[0034] After milling the implant **100**, the fabricator may further refine the implant **100** (step **122**). For example, a surface **124** of the base **104** (see FIG. **1**) may be treated to enhance the implantation of the implant **100** in the site where the nonfunctional tooth was extracted, for example, by facilitating the growth of bone to the base **104**. Examples of the surface treatment may include processes that increase the surface area as shown in FIG. **7**, thereby enhancing the ability of the bone of the jaw to "adhere" to the implant. For example, the base **104** may be etched or sand blasted. Alternatively, the base **104** may be coated with various material to enhance bone or ligamental integration. An example of such a material is hydroxyapatite. Further, as shown in FIG. **8**, one or more holes **126** may be bore into or through the base **104** of the implant **100**, which holes are illustrated by dashed lines.

[0035] Further refining of the implant **100** may include machining a collar **128** between the abutment **102** and the base **104** (see FIG. **1**) as to enhance gingival attachment to the implant. When the finished implant **100** is completed, the fabricator may sterilize and package the implant **100** for shipment to the dentist.

[0036] Upon receipt of the implant **100** (step **130**), the dentist may then extract the nonfunctional tooth (step **132**) as shown in FIG. **9**, thereby leaving an extraction site. The extraction of the nonfunctional tooth should be accomplished as atraumatic as possible. The dentist may treat the extraction site (step **134**), such as removing the periodontal ligament L (see

FIG. 3). As shown in FIG. **10**, the dentist may then place the implant **100** into the extraction site (step **136**) For example, the dentist may gently tap the implant **100** into place.

[0037] The implant **100** may then be stabilized and temporized. With reference to FIG. **11**, the implant **100** may be stabilized by mounting a temporary crown **141** and then splinting the implant **100** with the crown **142** with a wire **144** connected to adjacent teeth **146**. Alternatively, a custom-made lingual metal plate **148** may be fitted and cemented to the lingual side of the implant **100** with temporary crown **142** and the adjacent teeth **146**. The lingual plate **148** may include an implant protrusion **150** that protects the biting or incisal edge of the implant **100** by extending slightly above a top surface of the temporary crown **142**.

[0038] Still alternatively, the implant **100** may be stabilized by fabricating a loose-fitting temporary crown **152** with a pair of metal wings **154**. The temporary crown **152** is configured to adapt precisely to the adjacent teeth **146** and is cemented thereto. In contrast to a conventional Maryland bridge, the temporary crown **52** fits over the abutment **102** of the implant **100** but is not in intimate contact with the abutment **102**, thereby preventing movement of the implant **100**.

[0039] When integration of body elements (bone or ligament) with the implant element is complete or ready, any temporary crown may be removed, and a permanent crown **106** (see FIG. **4**) may be fabricated and installed on the abutment **102** of the implant **100** (step **140**).

[0040] For the purposes of this description, the term "substantially identical" has been used to describe and relate the topography of the base **104** of the implant **100** with that of the nonfunctional tooth T. Insofar as accurate as the scanning process (step **110**) is and as accurate as the data are contained in the digital file (step **114**) in representing the anatomical topography of the nonfunctional tooth T, there may be minor discrepancies between the topographies of the base of the implant and the root of the tooth. Such discrepancies do not depart from the scope and spirit of the invention in which an implant is used to replace a nonfunctional tooth as atraumatic as possible. In addition, in some of the embodiments, the base **104** may have a topography that is substantially identical to the anatomical topography of a portion of the root R and not the entire root itself.

Furthermore, with reference to FIG. **12**, in embodiments where the surface **124** of the base **104** is treated to enhance bone growth thereto, for example, with the formation of discontinuities **156** resulting from etching, the term "substantially identical" is used to indicate that the topography of the base **104** absent the discontinuities **156** (as indicated by dashed lines D) is substantially the same as or substantially replicates the anatomical topography of the root R.

[0041] In some of the embodiments in actual practice, the topography of the base of the implant may not substantially match or replicate the topography of the nonfunctional tooth. In such embodiments, the implant still satisfactorily functions as an atraumatic replacement for a nonfunctional tooth. Accordingly, in a number of embodiments, the implant **100** has a base **104** with a topography that generally represents the root R of the nonfunctional tooth T to be replaced which is shown in FIGS. **1** and **2**. Further, the implant **100** of the invention is implanted by inserting and gently tapping or press fit, not by screwing or rotation in the case of the bores of conventional implants. In addition, the implant **100** does not require an abutment to be attached subsequent to the implantation of the base.

[0042] Referencing FIG. **13**, in a number of embodiments an implant **200** of the invention with a base **202** and an abutment **204** may be configured to retain a removable prosthesis **206**. More specifically, analogous to the description above, the implant **200** may be fabricated so that the base **202** has a topography that is substantially identical to that of a root R. Rather than being configured to receive a permanent crown as described above, in some of the embodiments the abutment **204** may be configured to releasable engage with a prosthesis. For example, the abutment **204** may include a post **208** with an enlarged head **210**. The removable prosthesis **206** may include a socket **212** that is configured to complement the shape of the post **208**. Accordingly, the prosthesis **206** may be urged onto the abutment **204** for engagement. As shown in FIG. **13**, a plurality of implants **204** may be implanted in a patient depending upon the configuration of the prosthesis.

[0043] In other embodiments of the invention as shown in FIG. **14**, an implant **300** may include a base **302** and an abutment **304**. Analogous to the foregoing description, the implant **300** may be fabricated so that the base **302** has a topography that is substantially replicates that of a root R. Rather than having a unitary construction as described above, the implant **300** has a

non-unitary construction. More specifically, the abutment **304** is a separate element. As shown, abutment **304a** is configured to receive a permanent crown, and abutment **304b** is configured to releasably engage with a prosthesis.

[0044] To integrate the implant **300**, the base **302** may include a threaded hole **306** for receiving and engaging with a screw **308** of abutment **304a** or a threaded post **310** of abutment **304b**. The permanent-crown abutment **304a** may include a through hole (not shown) for receiving the screw **308**. In addition, the hole **306** may be configured to receive a neck **312** of abutment **304a**.

[0045] The principles of the invention may be applied to a scenario in which a tooth is not present, but rather there is a prepared extraction site. In these embodiments, the extraction site where an implant is to be implanted may be scanned to yield a digital file containing data representing the anatomical topography of the extraction site. An implant may then be milled with a base having a topography that complements the topography of the extraction site for atraumatic implantation in the extraction site.

[0046] Those skilled in the art will understand that the preceding embodiments of the present invention provide the foundation for numerous alternatives and modifications thereto. For example, the principles of the invention are not limited to uses in tooth replacement procedures but are applicable to any medical procedure in which it is advantageous to utilize a custom-made prosthesis that resembles or essentially replicates a nonfunctional anatomical part. These other modifications are also within the scope of the present invention. Accordingly, the present invention is not limited to that precisely as shown and described in the present invention.